TMDLS FOR PHOSPHORUS, COPPER, AND ZINC FOR THE POTEAU RIVER NEAR WALDRON, AR

(Reach 11110105-031L)

FINAL
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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of a pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be allocated to point sources and nonpoint sources discharging to the waterbody.

This report presents TMDLs for total phosphorus, copper, and zinc for the Poteau River near Waldron in western Arkansas (reach 11110105-031L). The watershed for this reach of the Poteau River is located within the Arkansas River Valley ecoregion and is over 95% forest and pasture. The drainage area upstream of the impaired reach (11110105-031L) is 43.9 square miles. The Poteau River flows into Oklahoma approximately 22 miles downstream of the impaired reach.

This stream reach was cited as not supporting its designated use of aquatic life according to the final 2002 Arkansas 303(d) list and the draft 2004 Arkansas 303(d) list . Based on the 303(d) listing and a 1994 study by the Arkansas Department of Environmental Quality (ADEQ), the suspected sources of impairment include a municipal point source (the City of Waldron wastewater treatment plant (WWTP)) and an industrial point source (Tyson Foods at Waldron). The 1994 study by ADEQ showed that these two facilities appear to have a noticeable impact on water quality in the Poteau River.

Historical monitoring data for phosphorus, copper, and zinc have been collected by ADEQ in the Poteau River upstream of the two point sources (ARK0054) and downstream of the two point sources (ARK0055). These data were summarized and plotted. In general, concentrations of phosphorus, copper, and zinc tended to be higher at the downstream station.

Numeric water quality criteria for copper and zinc were calculated using the equations in Arkansas Regulation No. 2 with the default hardness for the Arkansas River Valley ecoregion. Arkansas has no numeric instream criterion for phosphorus. Previous versions of Arkansas Regulation No. 2 included a guideline of 0.1 mg/L for total phosphorus in streams. Although this

guideline was never a criterion, it was still considered to be a reasonable benchmark for evaluating phosphorus levels in streams for the protection of aquatic life; therefore, it was used as the target concentration, or endpoint, for the phosphorus TMDL.

The copper and zinc wasteload allocations (WLAs) were developed for 7Q10 flow conditions due to potential toxicity from these parameters and ADEQ's permitting policies for toxic substances. The copper and zinc load allocations (LAs) were developed for average annual flow conditions in order to quantify the nonpoint source component of the TMDL. The phosphorus TMDL was developed for average annual conditions because aquatic life impairments typically occur as a result of long term exposure to elevated nutrient concentrations rather than short term increases in nutrient concentrations. All three TMDLs were developed using a simple mass balance approach assuming conservative mixing.

The margin of safety (MOS) for the copper and zinc TMDLs was implicit based on conservative assumptions. An explicit MOS of 10% was used for the phosphorus TMDL.

Point source reductions for copper will be required for both facilities because averages of recent effluent concentrations reported on discharge monitoring reports (DMRs) are greater than the allowable effluent concentrations. Both facilities had individual months with average effluent concentrations of zinc that exceeded the allowable concentration, but the average effluent concentrations over 7–12 months at both facilities are already less than the allowable concentration. Point source reductions for phosphorus will be required for both facilities because averages of recent effluent concentrations reported on DMRs are greater than the allowable effluent concentrations.

No nonpoint source reductions of copper and zinc are required for these TMDLs because the existing upstream concentrations of dissolved copper and dissolved zinc are less than the chronic water quality criteria. A nonpoint source reduction of 35% is needed for phosphorus.

The components of these TMDLs are summarized in Table ES.1.

Table ES.1. Summary of TMDLs for Poteau River reach 11110105-031L.

	Allowable loads (lbs/day) of:		
	Total Phosphorus	**Dissolved Copper**	**Dissolved Zinc**
WLA for point sources	22.73	0.061	0.566
LA for nonpoint sources	20.23	0.818	2.34
MOS	4.77	implicit	implicit
TMDL	47.73	0.879	2.91

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1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for total phosphorus, copper, and zinc for the Poteau River near Waldron in western Arkansas. This stream reach was cited as not supporting its designated use of aquatic life according to the final 2002 Arkansas 303(d) list (EPA 2003) and the draft 2004 Arkansas 303(d) list (Arkansas Department of Environmental Quality (ADEQ) 2005). The sources of contamination and causes of impairment from the draft 2004 303(d) list are shown in Table 1.1. The TMDLs in this report address impairments due to total phosphorus, copper, and zinc, but not other causes of impairment (siltation/turbidity and nitrate). The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and the Environmental Protection Agency's (EPA's) regulations in 40 CFR 130.7.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the load allocated to point sources of the pollutant of concern. The LA is the load allocated to nonpoint sources, including natural background. The MOS is a percentage of the TMDL that takes into account any lack of knowledge concerning the relationship between pollutant loadings and water quality.

Table 1.1. 303(d) listing for the stream reach in this task order (ADEQ 2005).

Stream Name and Reach No.	Impaired Use	Sources	Causes	Category	Priority
Poteau River 11110105-031L	Aquatic life	Surface erosion, industrial point source, municipal point source	Siltation / turbidity, nitrate, total phosphorus	5A	Medium
	Aquatic life	Industrial point source, municipal point source	Copper, zinc	5C	Medium

2.0 BACKGROUND INFORMATION

2.1 General Information

The study area for the TMDLs in this report is part of the Poteau River watershed near Waldron in western Arkansas (see Figure A.1 located in Appendix A). The Poteau River drains in a generally westerly direction and flows into Oklahoma about 22 miles downstream of the impaired reach (ADEQ 1994). The impaired portion of the Poteau River starts at the confluence of the Poteau River and East Fork Poteau River and extends approximately 7 miles downstream to the confluence with Jones Creek.

The Poteau River watershed is in the Arkansas River Valley ecoregion. The Poteau River watershed is also part of ADEQ Planning Segment 3I and US Geological Survey (USGS) Hydrologic Unit 11110105. The drainage area of the Poteau River is 43.9 square miles at the upstream end of the impaired reach and 73.5 square miles immediately upstream of its confluence with Jones Creek (USGS 1970).

2.2 Land Use

Land use data for the study area were obtained from the GEOSTOR database, which is maintained by the Center for Advanced Spatial Technology (CAST) at the University of Arkansas in Fayetteville. These data were based on satellite imagery from 1999. The spatial distribution of these land uses is shown on Figure A.2 (located in Appendix A) and land use percentages are shown in Table 2.1. These data indicate that approximately 55% of the study area is comprised of forest and approximately 41% is pasture. The larger areas of forest land use are generally remote from the streams in the study area, based on a review of the land use map. The areas of pasture land use generally extends to the banks of the streams. This would cause the practices on the pasture land use to have a greater effect on the instream water quality than the practices on the forest land use.

Table 2.1. Land use percentages for the study area.

Land use	Percentage of study area
Forest	54.8%
Pasture	41.1%
Urban	3.2%
Water	0.9%
Total	100.0%

2.3 Stream Flow

The USGS has published daily stream flow data for the Poteau River near Cauthron, AR (gage No. 07247000), which is downstream of the study area (see Figure A.1). The period of record for this station is from 1940 through 2004. Since September 1974, flow from approximately half of the upstream drainage area has been regulated by a series of floodwater detention reservoirs. For water years 1975 through 2004, the long term average flow for this gage is 244 cfs, resulting in a average flow per unit area of 1.20 cfs per square mile based on the drainage area of 203 square miles at the gage (USGS 2005).

The published 7Q10 flow for the Poteau River near Cauthron, AR is 0.02 cfs (USGS 1992). This 7Q10 flow includes contributions from the two point sources in Waldron as well as any leakage from Hinkle Lake Dam on Jones Creek. Based on these flow contributions and the difference in drainage areas (203 square miles at the USGS gage and 43.9 square miles upstream of the study area), a 7Q10 flow of zero was assumed for the study area.

2.4 Water Quality Standards

2.4.1 Designated Uses

Water quality standards for the Poteau River are given in Arkansas Regulation No. 2 (APCEC 2004a). The designated uses for this reach of the Poteau River include primary and secondary contact recreation; domestic, industrial, and agricultural water supply; and perennial fishery (where the drainage area is at least 10 square miles).

2.4.2 Metals

Section 2.508 of Regulation No. 2 provides both a narrative criterion and numeric criteria that apply to toxic substances including copper and zinc. The general narrative criterion is: "Toxic substances shall not be present in receiving waters, after mixing, in such quantities as to be toxic to human, animal, plant or aquatic life or to interfere with the normal propagation, growth and survival of the indigenous aquatic biota." Numeric criteria for dissolved copper and dissolved zinc include both acute and chronic criteria expressed as a function of hardness. Based on data from ADEQ monitoring station ARK0055, average hardness in the Poteau River downstream of Waldron is approximately 35 mg/L (ADEQ 2002). ADEQ's Continuing Planning Process (CPP) (ADEQ 2000) specifies that numeric criteria for metals such as copper and zinc should be calculated using the default hardness for each ecoregion (25 mg/L for the Arkansas River Valley ecoregion). Using the default hardness value, the acute and chronic criteria for dissolved copper and dissolved zinc in the Arkansas River Valley Ecoregion are calculated as shown in Table 2.2.

The acute criteria are based on toxicity resulting from short-term exposure to high concentrations, whereas chronic criteria are based on toxicity resulting from long-term exposure to lower concentrations. Since this report focuses on critical conditions over the long term, the chronic criteria were used to calculate the TMDLs for copper and zinc.

Table 2.2. Copper and zinc criteria for the Arkansas River Valley ecoregion.

Parameter	Acute Criterion (µg/L)		Chronic Criterion (µg/L)	
	Equation	Criteria	Equation	Criteria
Dissolved Copper	$0.960e^{[0.9422*\ln(\text{hardness})]-1.464}$	4.6	$0.960e^{[0.8545*\ln(\text{hardness})]-1.465}$	3.5
Dissolved Zinc	$0.978e^{[0.8473*\ln(\text{hardness})]+0.8604}$	35.4	$0.986e^{[0.8473*\ln(\text{hardness})]+0.7614}$	32.3

2.4.3 Phosphorus

Arkansas Regulation No. 2 includes the following narrative criteria concerning phosphorus (APCEC 2004a):

> "Materials stimulating algal growth shall not be present in concentrations sufficient to cause objectionable algal densities or other nuisance aquatic vegetation or otherwise impair any designated use of the waterbody. Impairment of a waterbody from excess nutrients are dependent on the natural waterbody characteristics such as stream flow, residence time, stream slope, substrate type, canopy, riparian vegetation, primary use of waterbody, season of the year and ecoregion water chemistry. Because nutrient water column concentrations do not always correlate directly with stream impairments, impairments will be assessed by a combination of factors such as water clarity, periphyton or phytoplankton production, dissolved oxygen values, dissolved oxygen saturation, diurnal dissolved oxygen fluctuations, pH values, aquatic-life community structure and possibly others. However, when excess nutrients result in an impairment, based upon Department assessment methodology, by any established, numeric water quality standard, the waterbody will be determined to be impaired by nutrients."

Although Arkansas Regulation No. 2 does not include an instream water quality criterion for phosphorus, it specifies the following requirements for point sources discharging into impaired waterbodies:

> "All point source discharges into the watershed of waters officially listed on Arkansas' impaired waterbody list (303d) with phosphorus as the major cause shall have monthly average discharge permit limits no greater than those listed below. Additionally, waters in nutrient surplus watersheds as determined by Act 1061 of 2003 Regular Session of the Arkansas 84th General Assembly and subsequently designated nutrient surplus watersheds may be included under this Reg. if point source discharges are shown to provide a significant phosphorus contribution to waters within the listed nutrient surplus watersheds.

Facility Design Flow	Total Phosphorus discharge limit
15 MGD or more	Case by case
3 to <15 MGD	1.0 mg/L
1 to <3 MGD	2.0 mg/L
0.5 to <1.0 MGD	5.0 mg/L
<0.5 MGD	Case by case

> "For discharges from point sources which are greater than 15 MGD, reduction of phosphorus below 1 mg/L may be required based on the magnitude of the phosphorus load (mass) and the type of downstream waterbodies (e.g., reservoirs, Extraordinary Resource Waters). Additionally, any discharge limits listed above may be further reduced if it is determined that these values are causing impairments to special waters such as domestic water supplies, lakes or reservoirs or Extraordinary Resource Waters."

2.4.4 Antidegradation

As specified in EPA's regulations at 40 CFR 130.7(b)(2), applicable water quality standards include antidegradation requirements. Arkansas' antidegradation policy is listed in Sections 2.201 through 2.204 of Regulation No. 2. These sections impose the following requirements:

- Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected.
- Water quality that exceeds standards shall be maintained and protected unless allowing lower water quality is necessary to accommodate important economic or social development, although water quality must still be adequate to fully protect existing uses.
- For outstanding state or national resource waters, those uses and water quality for which the outstanding waterbody was designated shall be protected.
- For potential water quality impairments associated with a thermal discharge, the antidegradation policy and implementing method shall be consistent with Section 316 of the Clean Water Act.

2.5 Nonpoint Sources

As indicated in Table 1.1, the 303(d) list did not specifically mention nonpoint sources as a primary cause of impairment for phosphorus, copper, or zinc. Previous studies have attributed nonpoint sources of pollution in the watershed to runoff from agricultural activities, particularly cattle and poultry farming (ADEQ 1994).

2.6 Point Sources

Based on a previous study of the Poteau River (ADEQ 1994), there are two facilities in the study area with point source discharges that are permitted through the National Pollutant

Discharge Elimination System (NDPES). Design flows and relevant permit limits for these two facilities are presented in Table 2.3 and locations of these facilities are shown on Figure A.3. The NPDES permits for both facilities were renewed in 2004. Relevant effluent data reported by each facility on Discharge Monitoring Reports (DMRs) were downloaded from the Permit Compliance System (PCS) web site (EPA 2005) and are summarized in Table 2.4.

Table 2.3. Design flows and permit limits for point source discharges.

NPDES Number	Facility Name	Design Flow (MGD)	Parameter	Monthly Average Permit Limits
AR0038482	Tyson Foods Inc. Waldron Facility	1.25	Total Phosphorus	2 mg/L*
			Copper	Report only
			Zinc	Report only
AR0035769	City of Waldron Wastewater Treatment Plant (WWTP)	0.85	Total Phosphorus	Report only
			Copper	Report only
			Zinc	Report only

* Not effective until December 1, 2007 (end of 3 year compliance period).

Table 2.4. Summary of DMR data for point source discharges.

Facility Name and NPDES No.	Period of Record	Parameter*	Statistics on monthly average values			
			No. of Values	Minimum	Maximum	Average
Tyson Foods Inc. Waldron Facility (AR0038482)	Dec. 2004 - Jul. 2005	TP conc. (mg/L)	7	0.52	6.96	2.53
		Cu conc. (µg/L)	7	6.0	75	17
		Zn conc. (µg/L)	7	6.0	100	62
		TP load (lbs/day)	8	5.3	71.0	29.7
		Cu load (lbs/day)	7	0.02	0.62	0.14
		Zn load (lbs/day)	7	0.05	0.90	0.51
City of Waldron WWTP (AR0035769)	Aug. 2004 - Jul. 2005	TP conc. (mg/L)	12	0.16	2.99	1.18
		Cu conc. (µg/L)	12	1.5	245	39
		Zn conc. (µg/L)	12	5.0	184	61
		TP load (lbs/day)	12	1.0	15.2	5.6
		Cu load (lbs/day)	12	0.01	1.08	0.19
		Zn load (lbs/day)	12	0.03	0.90	0.30

* TP = total phosphorus, Cu = total copper, and Zn = total zinc. Although the water quality standards for metals are expressed as dissolved concentrations, NPDES permittees are required to measure and report total concentrations.

2.7 Previous Studies

In 1994, ADEQ conducted a water quality investigation of the Poteau River near Waldron (ADEQ 1994). This investigation included collection of field data to characterize water chemistry, periphyton, macroinvertebrates, and fish communities upstream and downstream of point source discharges from the City of Waldron WWTP and the Tyson Waldron facility. The investigation revealed high nutrient concentrations in the effluent of both facilities and in the Poteau River downstream of the discharges. In particular, the Tyson discharge contained a high ortho-phosphate concentration and the City of Waldron discharge contained a high nitrate concentration. The study also revealed that the City of Waldron discharge contained dissolved copper and zinc concentrations that significantly exceeded the water quality criteria. The discharge from the Tyson facility contained zinc concentrations that slightly exceeded the water quality criteria. As a result, dissolved copper and zinc concentrations in the Poteau River downstream of the discharges slightly exceeded the water quality criteria.

3.0 EXISTING WATER QUALITY CONDITIONS

3.1 General Description of Data

Nutrient and metals data have been collected by ADEQ at approximately monthly intervals at two locations on the Poteau River within the study area. As shown on Figure A.3 (located in Appendix A), ADEQ Station ARK0054 is located upstream of the two point source discharges (Tyson Foods and City of Waldron WWTP) and ADEQ Station ARK0055 is located downstream of the two point source discharges. Data from these stations were obtained from the ADEQ web site. Time series plots of the data are shown on Figures B.1 – B.6 (located in Appendix B) and summary statistics are presented in Table 3.1. Comparing the data for these two stations, concentrations of total phosphorus, dissolved copper, and dissolved zinc tend to be higher at the downstream station (ARK0055).

Table 3.1. Summary of historical data for ADEQ Stations ARK0054 and ARK0055.

Station ID	Parameter*	Period of Record	No. of values	Min.	Max.	Avg.	No. of values above chron. crit.	% of values above chron. crit.
ARK0054	Cu, µg/L	1/03/95 - 9/21/04	38	<0.5	6.3	1.78	2	5%
	Zn, µg/L	1/03/95 - 9/21/04	37	<1.0	13.3	5.08	0	0%
	TP, mg/L	9/11/90 - 9/06/05	137	<0.02	12.1	0.30	--	--
ARK0055	Cu, µg/L	1/03/95 - 10/04/05	55	<0.5	17.4	4.63	31	56%
	Zn, µg/L	1/03/95 - 10/04/05	53	1.8	81.3	27.0	18	34%
	TP, mg/L	9/11/90 - 10/04/05	173	<0.02	25.76	3.65	--	--

* TP = total phosphorus, Cu = dissolved copper, and Zn = dissolved zinc.

This stream was assessed as not supporting aquatic life because more than 10% of the measured copper and zinc values exceeded the criteria at Station ARK0055. As shown in Table 3.1, 56% of the copper values and 34% of the zinc values exceeded the chronic criteria at ARK0055.

3.2 Seasonal Patterns

The numeric criteria for copper and zinc do not vary seasonally, nor does the narrative criteria for phosphorus. Seasonal variations in existing water quality may provide additional insight into the causes of water quality impairment. Seasonal plots of the data for total phosphorus, dissolved copper, and dissolved zinc are shown on Figures C.1 – C.6 (located in Appendix C). These plots do show slight seasonal variability, but this variability may be attributed to seasonal variations in stream flow.

3.3 Relationships with Flow

Plots of total phosphorus, dissolved copper, and dissolved zinc versus stream flow were developed to examine potential correlations (Figures D.1 – D.6 in Appendix D). The flow data used for these plots was from USGS gage number 07247000 (Poteau River near Cauthron, AR). These plots show that the highest concentrations for these parameters generally occurred at low flow conditions.

4.0 TMDL DEVELOPMENT FOR COPPER AND ZINC

4.1 Critical Conditions and Seasonality

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Also, both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to consider seasonal variations for meeting water quality standards.

Allowable loadings of copper and zinc should be calculated using a critical flow that is protective for toxic substances because high concentrations of copper or zinc could cause harm to aquatic life within a short period of time. ADEQ uses the 7Q10 flow when they conduct screening calculations involving metals and when they calculate water quality based permit limits for metals; these procedures are documented in the Arkansas CPP (ADEQ 2000). The 7Q10 flow was used for the copper and zinc TMDLs in this report.

These metals TMDLs were developed on an annual basis rather than for individual seasons because the numeric criteria for copper and zinc do not vary seasonally and the point source discharges do not have seasonal permit limits for copper or zinc.

4.2 Establishing the Water Quality Targets

As mentioned in Section 2.4, Arkansas has both acute and chronic criteria for dissolved copper and dissolved zinc. Since this report focuses on critical conditions over the long term, the chronic criteria were used to calculate the TMDLs. The chronic criteria are 3.5 μg/L for dissolved copper and 32.3 μg/L for dissolved zinc.

4.3 Wasteload Allocation

A WLA was developed for the two point sources discussed in Section 2.6. With a 7Q10 flow of zero, the Poteau River provides no dilution for the point source discharges during critical low flow conditions. The facilities must discharge effluent that meets the instream standard at the point of discharge. Under this scenario, the allowable load for each point source was calculated by multiplying the chronic water quality criterion by the respective design flow for that point

source. The permit limits that would be consistent with this scenario would be monthly average limits that are equal to the chronic water quality criteria (after converting them from dissolved concentrations to total concentrations since ADEQ specifies permit limits for metals as total concentrations). Table 4.1 shows the allowable effluent concentrations and loads as both dissolved and total values.

Table 4.1. Allowable point source concentrations and loads for copper and zinc.

Parameter	Facility and permit number	Flow rate (MGD)	Dissolved metals		Permit limits* (total metals)	
			Conc. (µg/L)	Load (lbs/day)	Conc. (µg/L)	Load (lbs/day)
Copper	City of Waldron WWTP (AR0035769)	0.85	3.5	0.025	9.2	0.065
	Tyson Foods - Waldron (AR0038482)	1.25	3.5	0.036	9.2	0.096
	Total allowable loads	--	--	0.061	--	0.161
Zinc	City of Waldron WWTP (AR0035769)	0.85	32.3	0.229	85.5	0.606
	Tyson Foods - Waldron (AR0038482)	1.25	32.3	0.337	85.5	0.891
	Total allowable loads	--	--	0.566	--	1.497

*Monthly average permit limits were calculated using a spreadsheet from ADEQ that includes a conversion between dissolved and total concentrations as well as a factor to estimate monthly average limits that correspond with certain confidence limits for maintaining water quality standards in the receiving stream.

Based on averages of recent effluent concentrations of total copper shown in Table 2.4 (17 µg/L for Tyson and 39 µg/L for the City of Waldron), both point source discharges will need to reduce their effluent concentrations to comply with the copper TMDL. For zinc, both facilities had individual months with average effluent concentrations that exceeded the allowable concentration of total zinc (85.5 µg/L), but the average effluent concentrations of total zinc over 7 –12 months at both facilities (62 µg/L for Tyson and 61 µg/L for the City of Waldron) are already less than the allowable concentration.

4.4 Load Allocations

During critical low flow conditions (i.e. 7Q10 conditions), the flow upstream of the point source discharges is estimated to be zero (See Section 2.3). It is also assumed that nonpoint source inflow to the Poteau River downstream of the point sources is negligible under 7Q10 conditions. In order to characterize the nonpoint source contribution to the TMDL, the annual average flow was used with the average concentration of the upstream monitoring data to determine the LA. As shown in Table 3.1, the average concentrations of dissolved copper and dissolved zinc at the upstream monitoring station were 1.78 μg/L and 5.08 μg/L, respectively. Using the appropriate conversion factors and the annual average flow (55.1 MGD; see Section 5.3), the LAs for copper and zinc were 0.818 lbs/day and 2.34 lbs/day, respectively.

No nonpoint source reductions of copper and zinc are required for these TMDLs because the existing upstream concentrations of dissolved copper and dissolved zinc are less than the chronic water quality criteria.

4.5 Margin of Safety

Both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to include a MOS to account for lack of knowledge concerning the relationship between pollutant loadings and water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative assumptions used in establishing the TMDL. An implicit MOS was incorporated though conservative assumptions for these metals TMDLs. One conservative assumption was that both point sources would be simultaneously discharging at design capacity during dry weather conditions. Another conservative assumption was the use of a default ecoregion hardness (25 mg/L) that was less than the average measured ambient hardness in the Poteau River (35 mg/L).

4.6 TMDLs

Each of these metals TMDLs was equal to the WLA (the sum of the individual permit loads) plus the LA plus the MOS (zero because it was defined as implicit). The TMDLs are summarized in Table 4.2.

Table 4.2. Summary of copper and zinc TMDLs for Poteau River.

	Allowable loads (lbs/day) of:	
	Dissolved Copper	**Dissolved Zinc**
WLA for point sources	0.061	0.566
LA for nonpoint sources	0.818	2.34
MOS	implicit	implicit
TMDL	0.879	2.91

4.7 Future Growth

Compliance with these copper and zinc TMDLs is based on keeping concentrations in the stream below the target concentrations rather than keeping the loads in the stream below certain amounts. Under critical low flow conditions, the flow in the stream consists entirely of effluent from point sources, so that point sources are required to meet the instream criterion at their discharge location (i.e. at the "end of the pipe"). As long as point source discharges or other inflows to the stream have concentrations of copper and zinc that do not exceed the chronic water quality criteria, then the effluent flow rates could increase, which would increase the allowable loading. Future growth for existing or new point sources discharging to the Poteau River is not limited by these TMDLs as long as the effluent concentrations of copper and zinc do not exceed the chronic water quality criteria.

5.0 TMDL DEVELOPMENT FOR PHOSPHORUS

5.1 Critical Conditions and Seasonality

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Also, both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to consider seasonal variations for meeting water quality standards. Aquatic life impairments typically occur as a result of long term exposure to elevated nutrient concentrations rather than short-term increases in nutrient concentrations. This phosphorus TMDL was developed for average annual conditions. The most obvious result of nutrients is algal blooms. When the algae die, the resultant biological oxygen demand consumes oxygen, which adversely affects aquatic life. The effect occurs within a short time but the build-up of nutrients and the conditions to start the algal bloom may occur over an extended time.

5.2 Establishing the Water Quality Target

As mentioned in Section 2.4, Arkansas has no numeric instream criterion for phosphorus for the protection of aquatic life in streams. At the time when this reach of the Poteau River was first added to the 303(d) list for phosphorus, Arkansas Regulation No. 2 contained a numeric guideline for total phosphorus of 0.1 mg/L for streams. Although the current version of Regulation No. 2 no longer includes that guideline, it is still considered a reasonable benchmark for evaluating phosphorus levels in streams for the protection of aquatic life. The total phosphorus concentration of 0.1 mg/L was used as the target concentration, or numeric endpoint, for this phosphorus TMDL.

5.3 TMDL

The first step in developing the components of the phosphorus TMDL was to calculate the assimilative capacity for the segment. The assimilative capacity for the segment was calculated by simply multiplying the target phosphorus concentration (0.1 mg/L) by the total flow in the stream for the segment (the average annual ambient flow from the watershed plus the

design flow of both point source discharges) and the appropriate conversion factor. The average annual ambient flow for the segment was estimated as the average annual flow per unit area for the USGS gage on the Poteau River (1.20 cfs per square mile) times the drainage area of the segment (73.5 square miles) minus the historical average contribution of point source discharges to the USGS measured flows (1.88 MGD). This resulted in average annual flow rate of 88.2 cfs, or 55.1 MGD. Including the combined design flows from the point source discharges (2.1 MGD), the total average annual flow for the segment is 57.2 MGD. The TMDL was set equal to the assimilative capacity, which was calculated to be 47.73 lbs/day of total phosphorus.

5.4 Margin of Safety

The next step was to account for the MOS. Both Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 require TMDLs to include a MOS to account for lack of knowledge concerning the relationship between pollutant loadings and water quality. The MOS may be expressed explicitly as unallocated assimilative capacity or implicitly through conservative assumptions used in establishing the TMDL. Ten percent of the assimilative capacity (i.e., 4.77 lbs/day) was set aside as an explicit MOS for this phosphorus TMDL. In addition to the explicit MOS, this TMDL also includes an unquantified implicit MOS due to the calculation of loads assuming that both point sources are simultaneously discharging at design capacity.

5.5 Wasteload Allocation

After subtracting the MOS from the TMDL, a WLA was calculated for the two point sources in the study area. Initially, an effluent phosphorus concentration of 2 mg/L was assumed for both point sources because that is the permit limit that will become effective for the Tyson facility in December 2007. The load for each point source was calculated as the design flow multiplied by 2 mg/L of total phosphorus and the appropriate conversion factor. When calculated with an effluent concentration of 2 mg/L, the WLA for both facilities consumed such a large portion of the total assimilative capacity that the remaining allowable load for nonpoint sources was unreasonably small. The allowable effluent concentrations were then reduced to 1.5 mg/L

for Tyson and 1.0 mg/L for the City of Waldron and the load calculations were repeated. This yielded allowable loads of 15.64 lbs/day for Tyson and 7.09 lbs/day for the City of Waldron. These loads did not exceed the available loading and were considered acceptable. The allowable effluent concentrations and loads are shown in Table 5.1.

Table 5.1. Allowable point source concentrations and loads for total phosphorus.

	Flow rate (MGD)	Concentration (mg/L)	Load (lbs/day)
Tyson Foods Facility (AR0038482)	1.25	1.5	15.64
City of Waldron WWTP (AR0035769)	0.85	1.0	7.09
Total WLA	--	--	22.73

Based on averages of recent effluent phosphorus concentrations shown in Table 2.4 (2.53 mg/L for Tyson and 1.18 mg/L for the City of Waldron), both point source discharges will need to reduce their effluent concentrations of phosphorus to comply with this TMDL.

5.6 Load Allocation

The LA for nonpoint source loading upstream of the point source discharges was calculated as the remaining available load after the MOS and WLA were subtracted from the TMDL. The LA was calculated to be 20.23 lbs/day.

Table 5.2. Summary of total phosphorus TMDL for Poteau River.

	Allowable Loads (lbs/day)
WLA for point sources	22.73
LA for nonpoint sources	20.23
MOS (10%)	4.77
TMDL	47.73

In order to calculate a percent reduction that would be needed for nonpoint source loads, the existing nonpoint source load was calculated as the median concentration of total phosphorus at ADEQ Station ARK0054 (0.065 mg/L) times the average annual flow for the segment

(57.2 MGD) and the appropriate conversion factor. This yielded an existing load of 31.0 lbs/day. To reduce this existing nonpoint source load to 20.23 lbs/day would require a 35% reduction.

5.7 Future Growth

Compliance with the phosphorus TMDL is based on keeping concentrations in the stream below the target concentration rather than keeping the load in the stream below a certain amount. The assimilative capacity of the stream will increase as the amount of flow in the stream increases. Increases in flow will allow for increased phosphorus loadings to the Poteau River. Future growth for existing or new point sources discharging to the Poteau River is not limited by this TMDL as long as the combined effect of the multiple point sources do not cause instream concentrations of phosphorus to exceed the target concentration of 0.1 mg/L.

6.0 MONITORING AND IMPLEMENTATION

In accordance with Section 106 of the federal Clean Water Act and under its own authority, ADEQ has established a comprehensive program for monitoring the quality of the State's surface waters. ADEQ collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for long term trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (*Water Quality Inventory*) and the 303(d) list of impaired waters, which is published as the 2002 Arkansas Integrated Water Quality Monitoring and Assessment Report (ADEQ 2002).

Point source reductions for this TMDL will be implemented through the NPDES permitting program, which is administered in Arkansas by ADEQ.

7.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, federal regulations require EPA to publicly notice and seek comment concerning the TMDL. Pursuant to a May 2000 consent decree, this TMDL was prepared under contract to EPA. After development of the draft version of this TMDL, EPA prepared a notice seeking comments, information, and data from the general public and affected public. Comments were submitted during the public comment period and this TMDL has been revised accordingly. Responses to these comments are included in Appendix E. EPA has transmitted the revised TMDL to ADEQ for implementation and for incorporation into ADEQ's current water quality management plan.

8.0 REFERENCES

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